Tropospheric ozone from assimilation of Aura data using different definitions of the tropopause

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NASA Goddard and JPL

Aura Science Team Meeting Boulder, Colorado, September 15, 2006

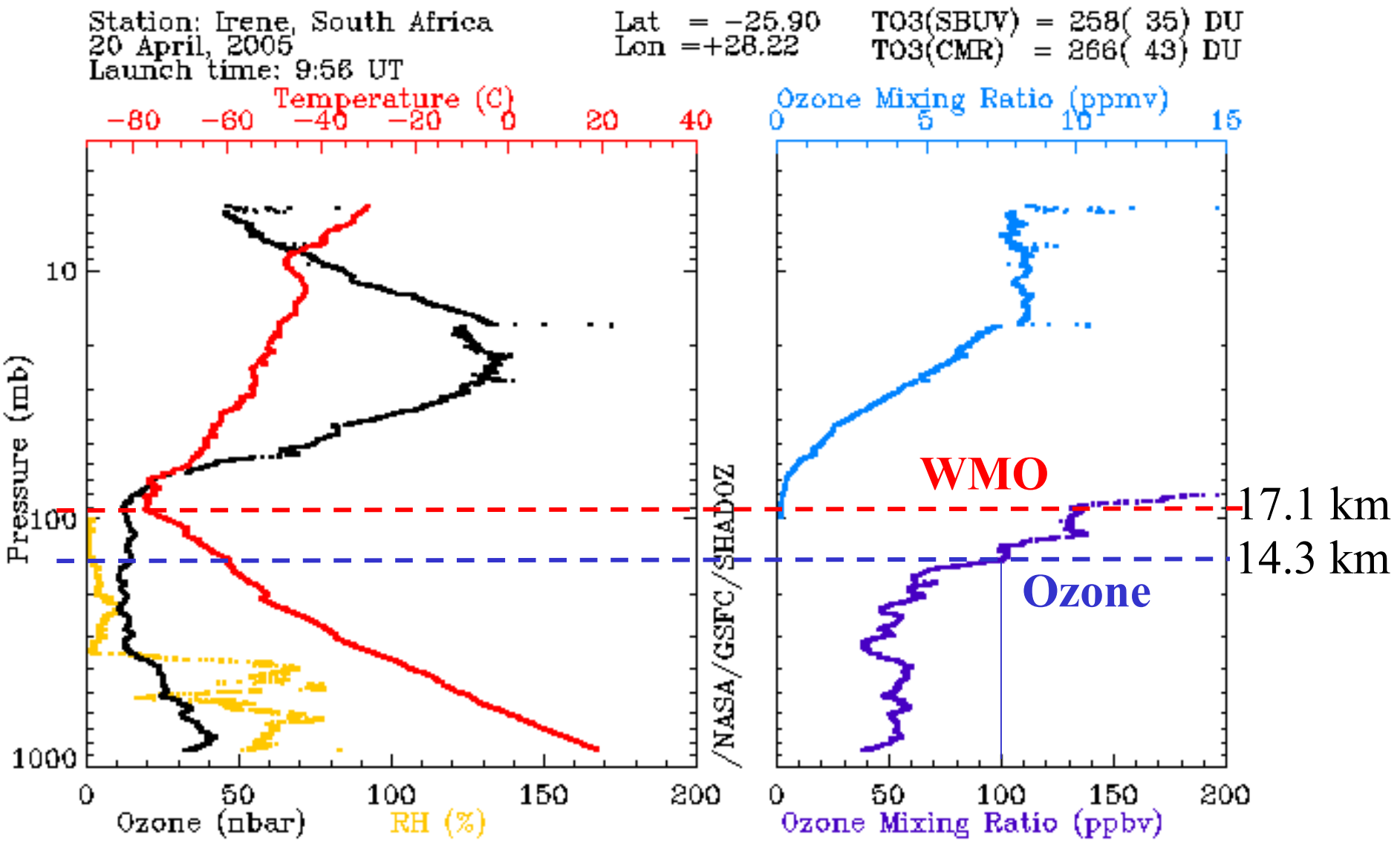
Tropospheric ozone

- One of the goals of the assimilation of Aura data is to produce maps of tropospheric ozone

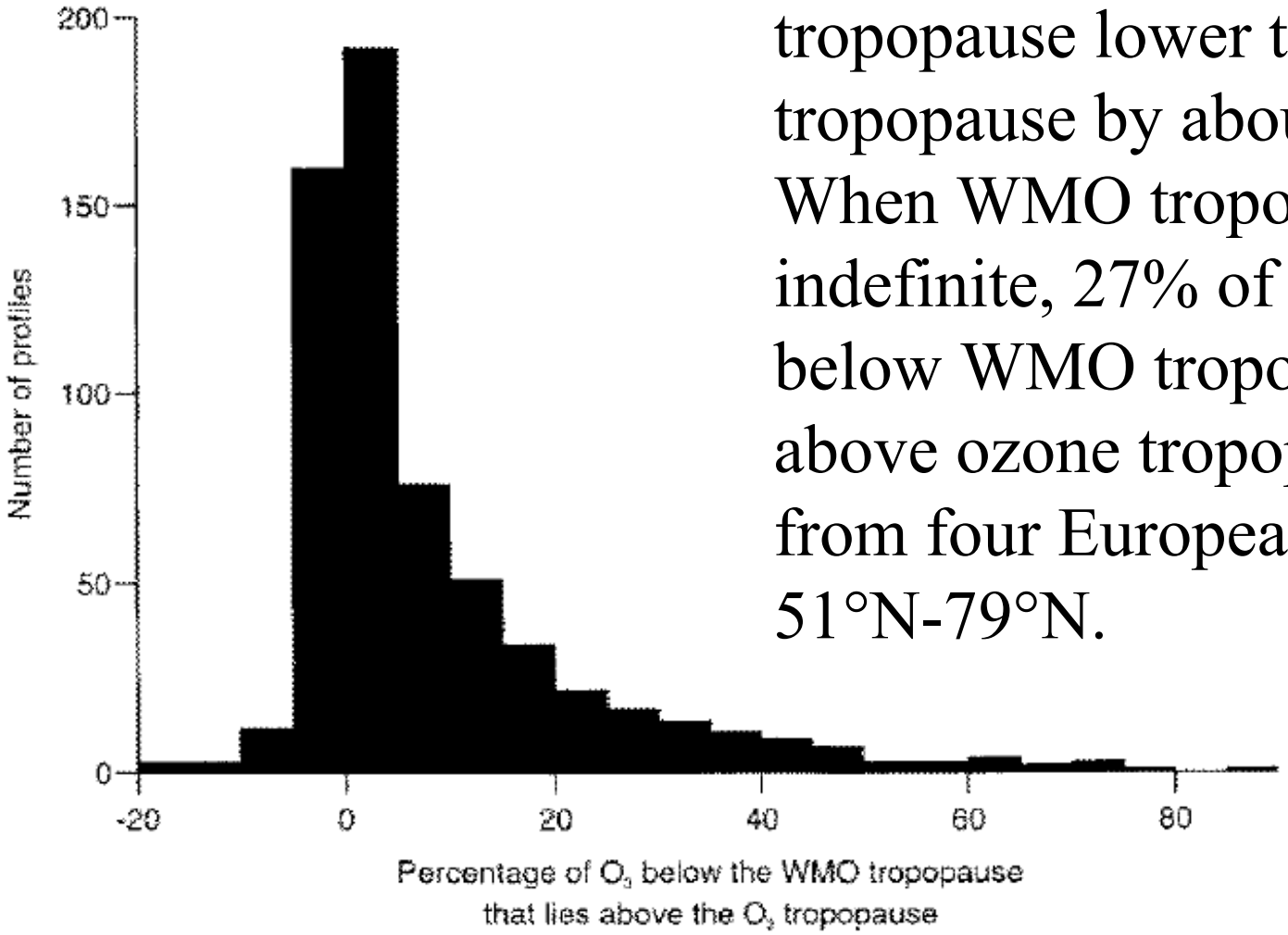
- Different definitions of tropopause:
  - temperature lapse rate (WMO)
  - dynamical
  - chemical

- **What is the sensitivity of the tropospheric ozone columns to different definitions of the tropopause?**

SHADOZ example



Background



- *Bethan et al 1996*: ozone defined tropopause lower than WMO tropopause by about 1 km. When WMO tropopause indefinite, 27% of the ozone below WMO tropopause lies above ozone tropopause. Sondes from four European stations 51°N-79°N.

Assimilation of Aura ozone data within a GCM

Data:

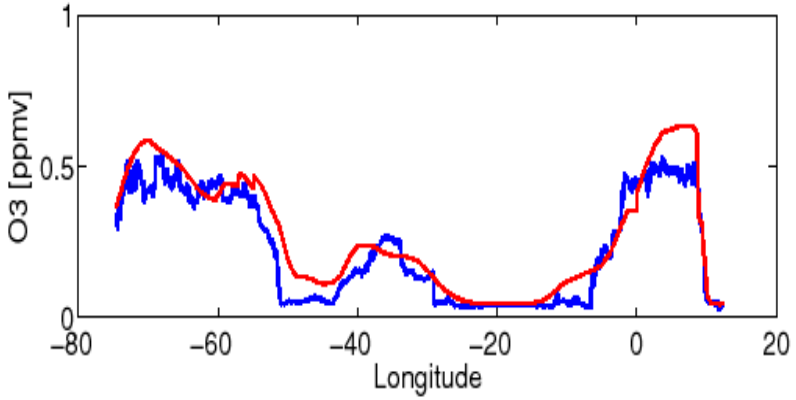
- **MLS** stratospheric ozone profiles (for pressure <= 216 hPa, some temporal gaps)
- US retrieved **OMI** total ozone data (for reflectivity < 15%)

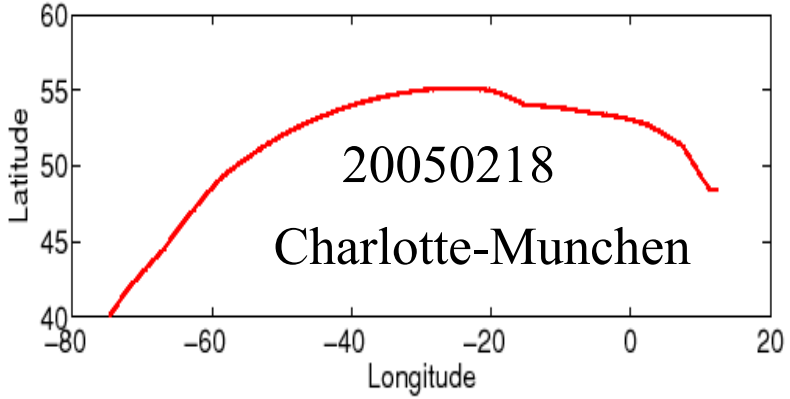
- Time period: **January-December 2005**.

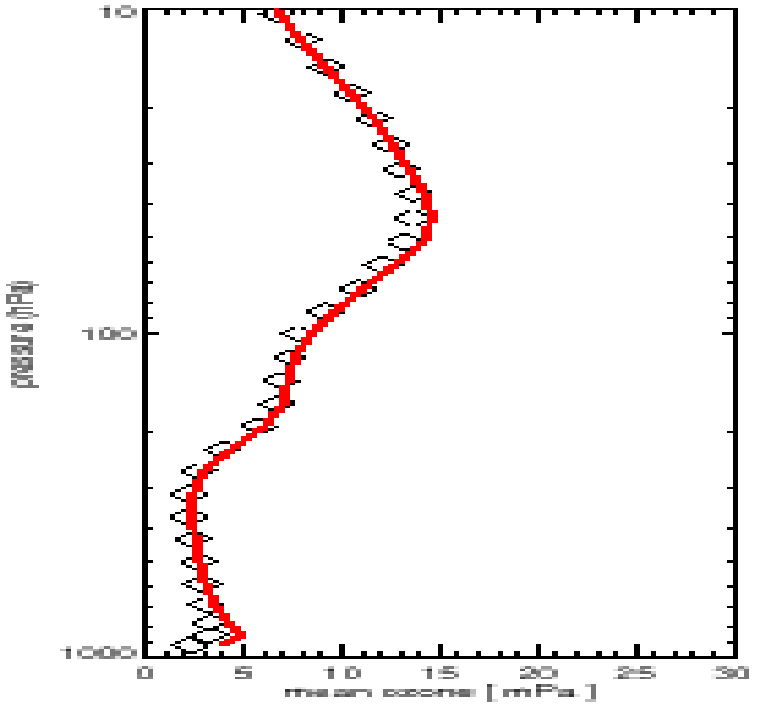
- The assimilation system model includes:
  - transport within GEOS-4 **general circulation model** constrained by meteorological analyses
  - parameterizations for stratospheric photochemistry and heterogeneous ozone loss
  - a parameterization of the tropospheric chemistry (for year 1998).

Sample validation

Assimilated ozone captures larger scale variability seen in **MOZAIC data** without obvious systematic offsets



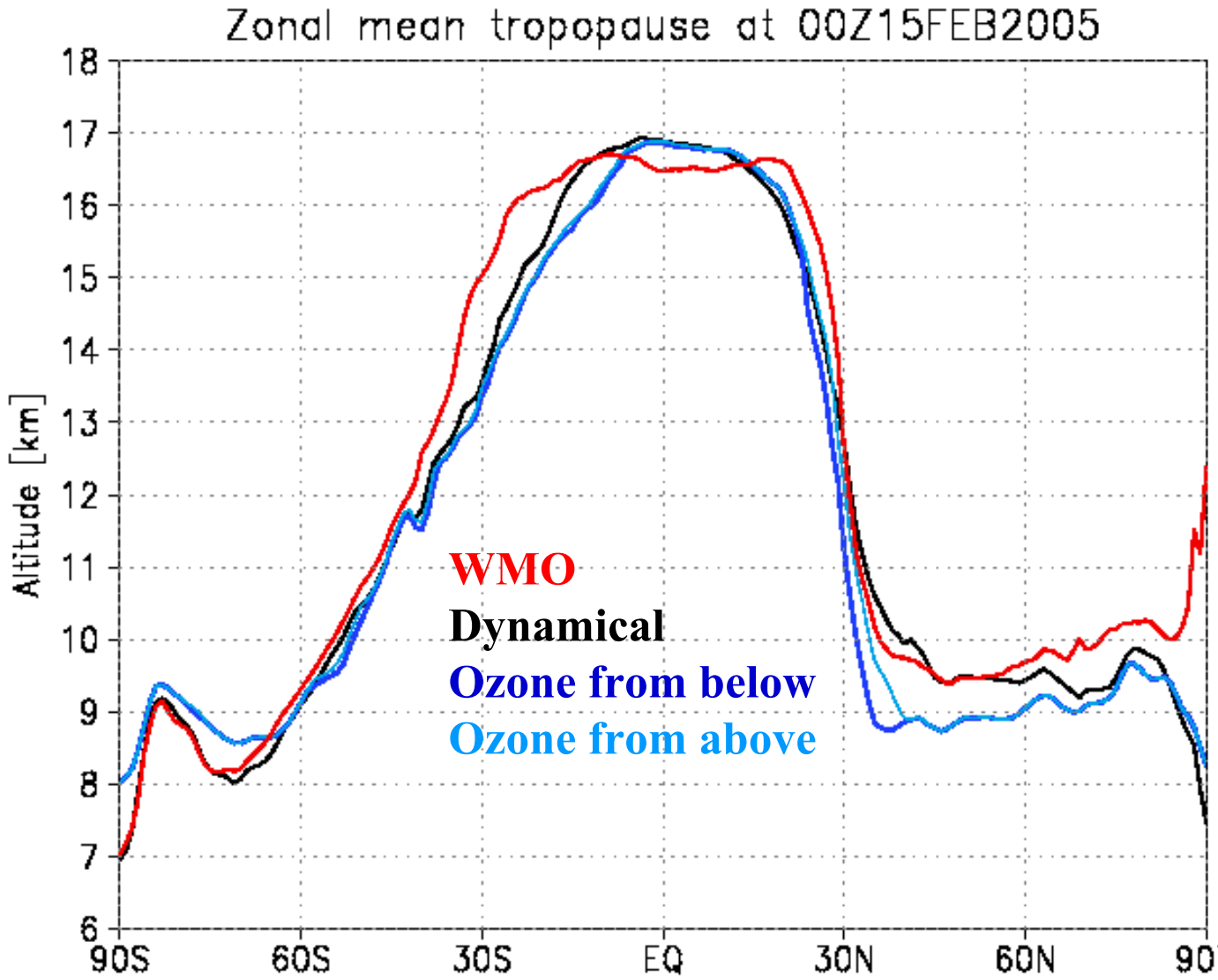




Mean differences between **assimilation** and **sondes** at Hohenpeissenberg for year 2005 are smaller than 10% between 10 and 500 hPa

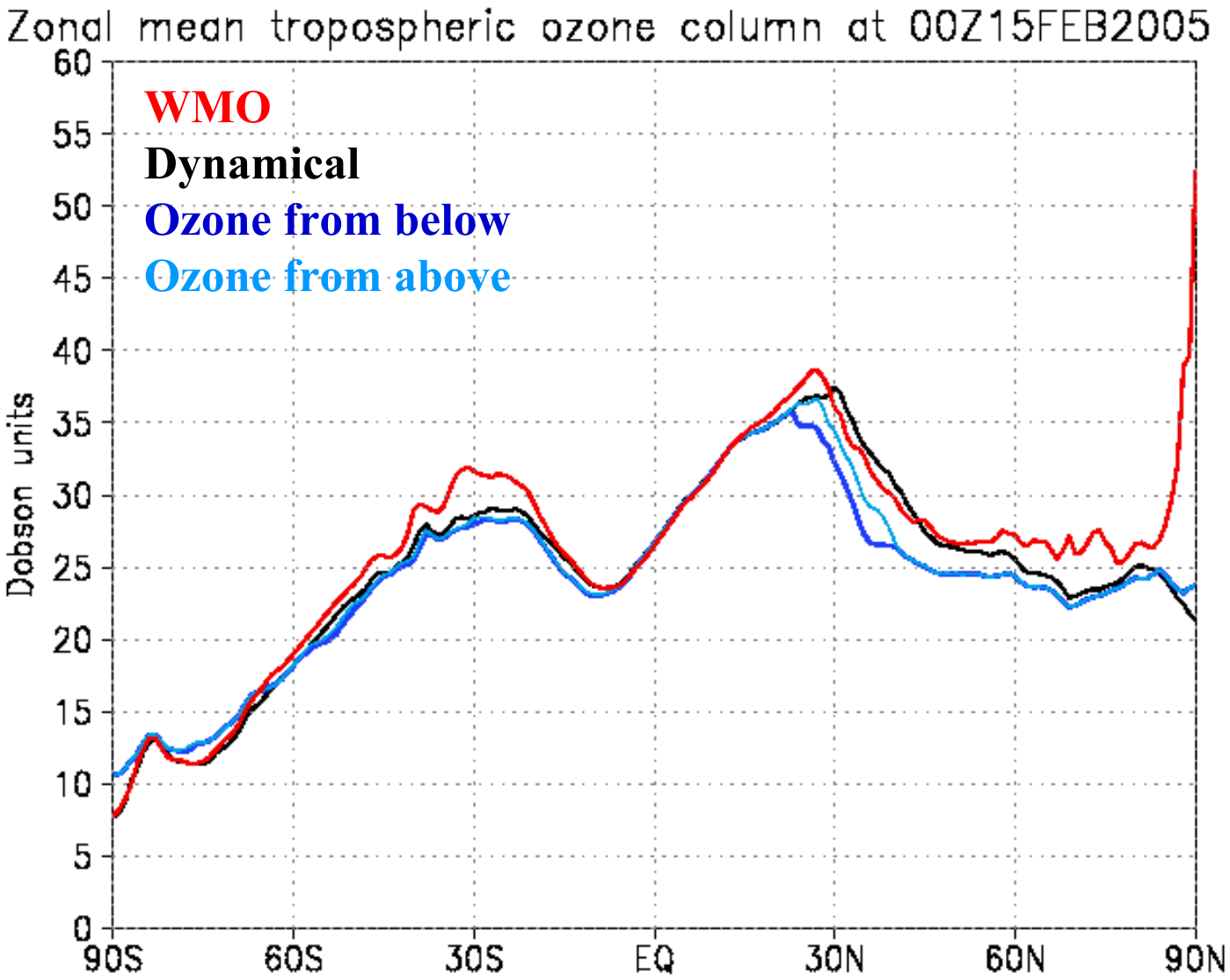
Tropopause definition	*Criterion*	*Pressure search range*
WMO (algorithm by Reichler et al 2003)	Lapse rate < 2K/km and does not exceed 2K/km for 2 km above	550 to 75 hPa
Dynamical	Lower of: |PV|=3.5 PVU or θ = 380 K	> 51 hPa
Ozone from below	Ozone = 0.1 ppmv	< 500 hPa
Ozone from above	Ozone= 0.1 ppmv	> 51 hPa

Zonal mean altitude of tropopause



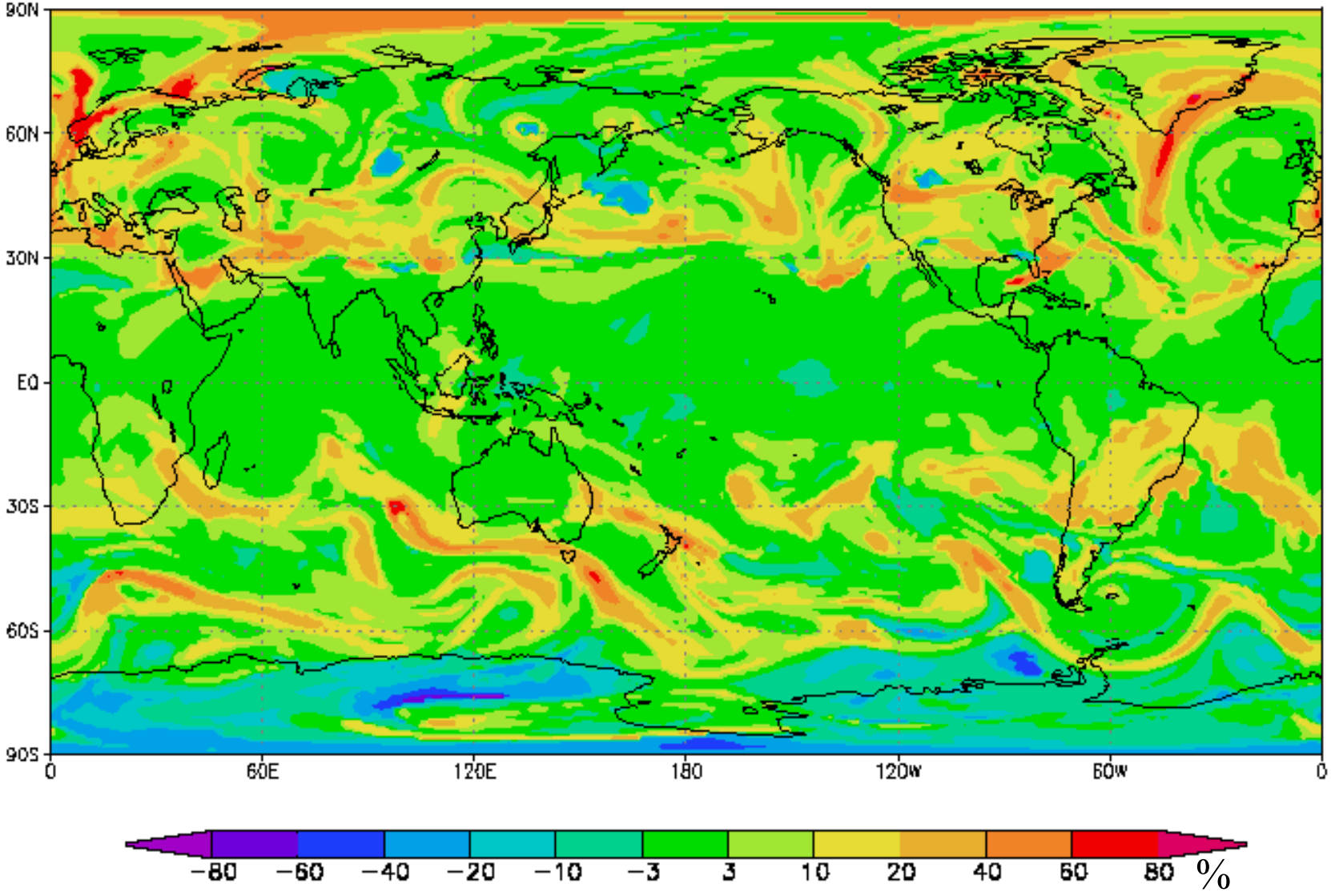
Ozone tropopause lower than WMO by 0.7 to 1 km in northern midlatitudes

Zonal mean tropospheric ozone column

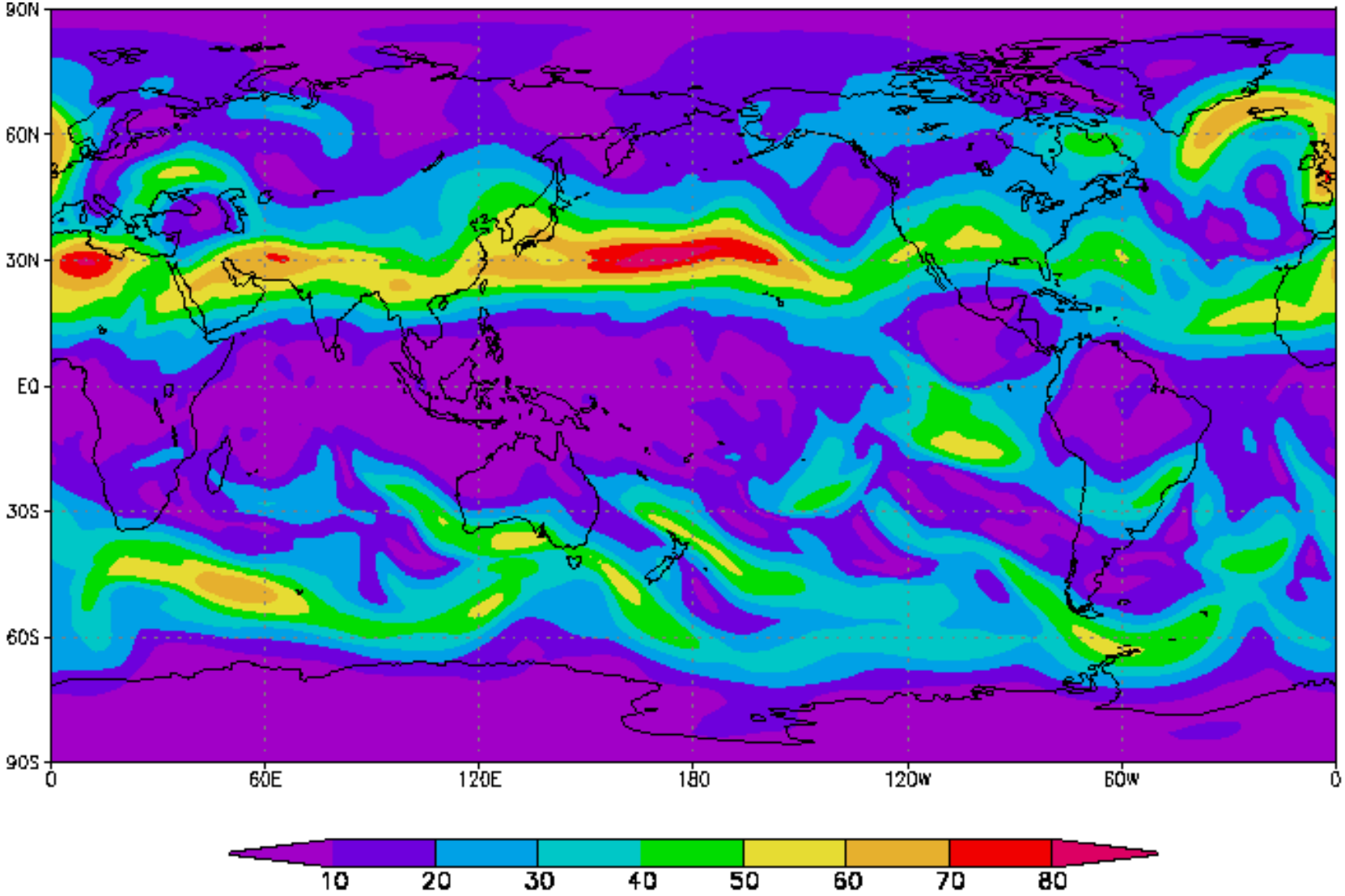


Tropospheric column using ozone tropopause lower than that using WMO Tropopause by ~2-3DU (10%) in northern midlatitudes

Percentage of ozone column below WMO tropopause that lies above ozone tropopause at 00Z15FEB2005



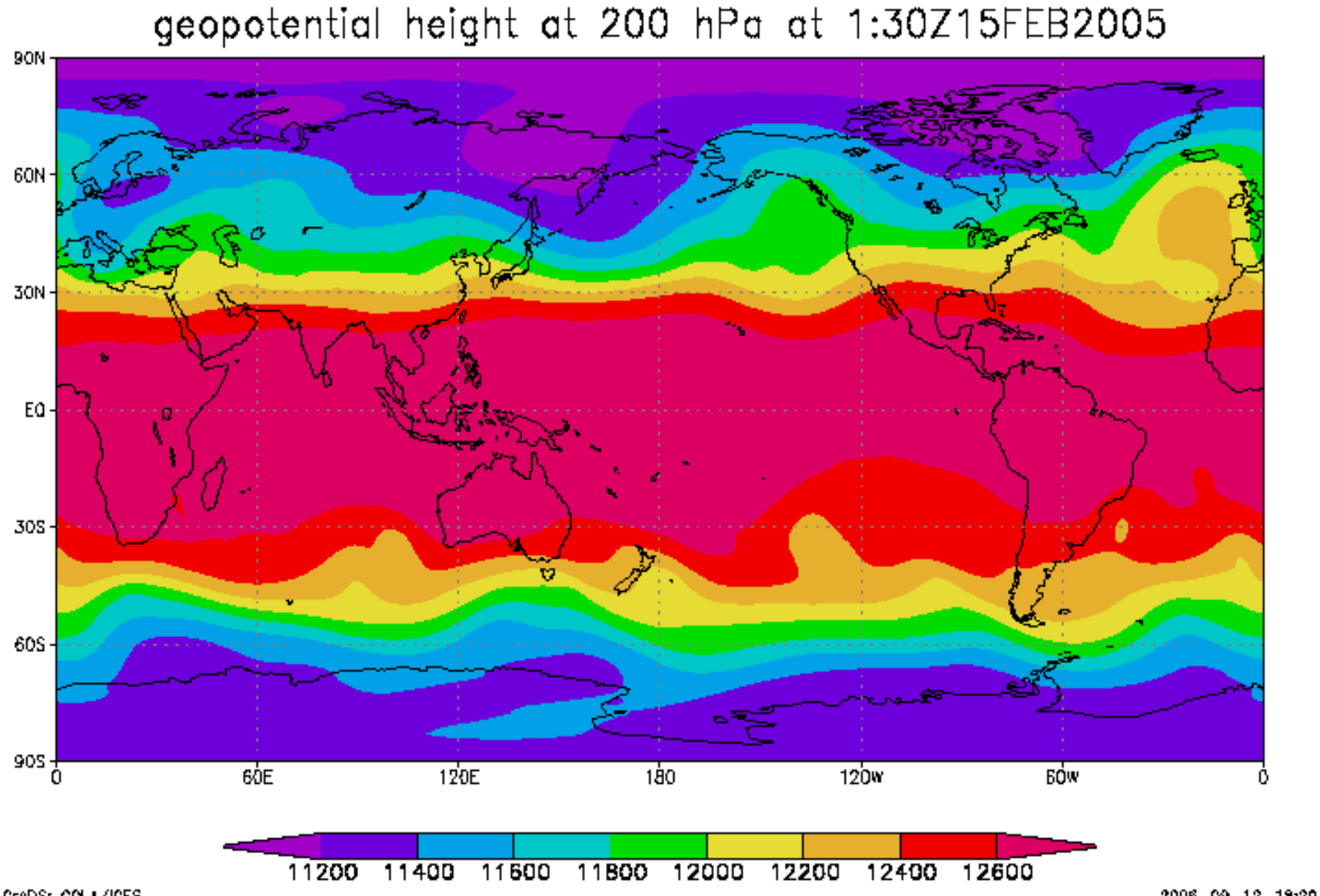
Wind magnitude at 200 hPa at 1:30Z15FEB2005



Conclusions

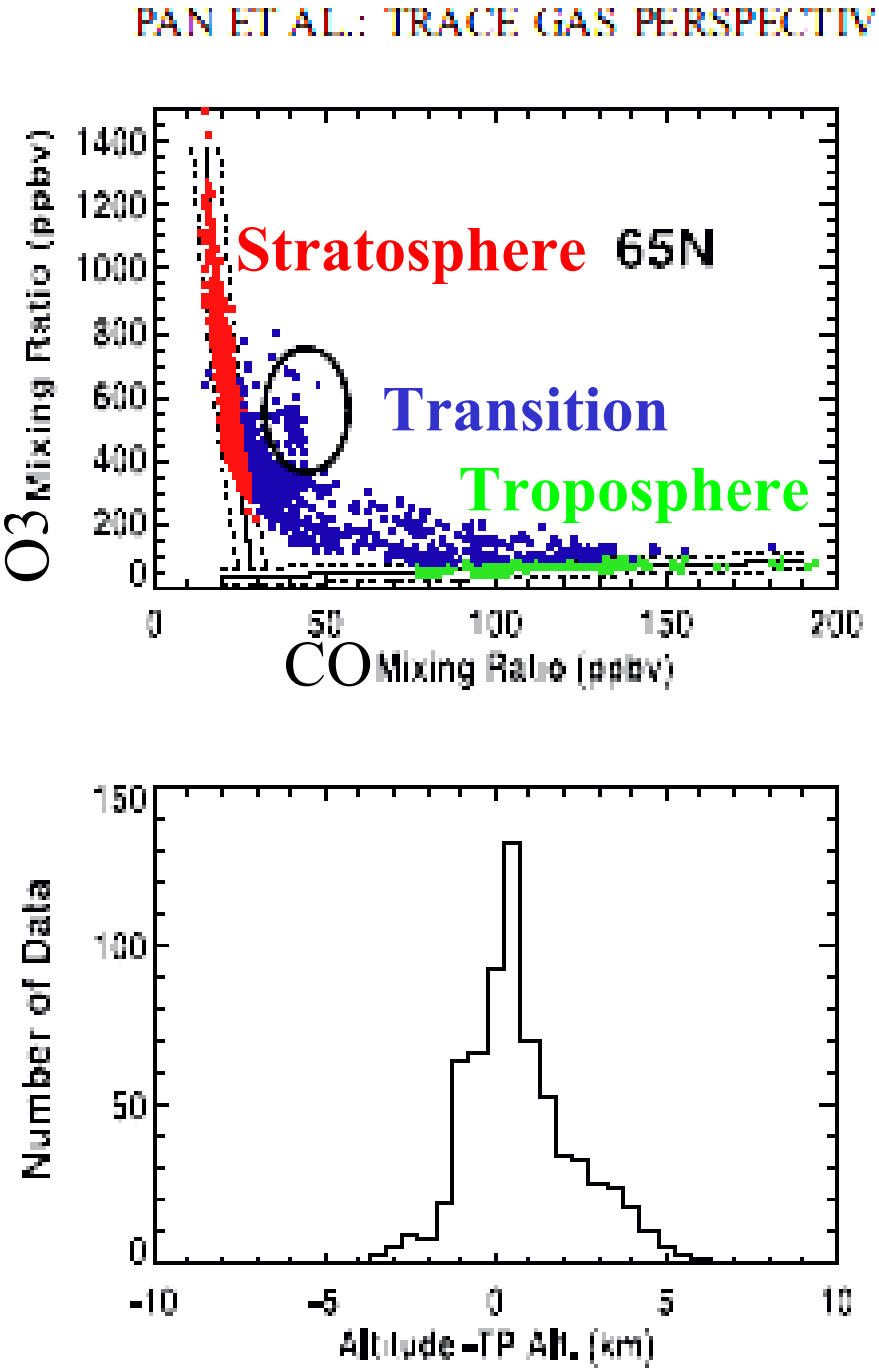
- **Assimilation of OMI and MLS** ozone provides a global dataset for studies of **ozone in the UTLS**.
- Assimilated ozone **agrees well** with independent **MOZAIC** and **Hohenpeissenberg** data.
- The choice of the **tropopause definition** has a **large impact** on the tropospheric ozone column.
- The amount of **ozone below WMO tropopause** that is **above ozone tropopause** is:
  - About **10% on average** in the northern middle latitudes in the example for February 15, 2005
  - Can **exceed 80%** depending on dynamical features.
- Comparisons with dynamical tropopause and applications to study of the stratosphere-troposphere exchange are planned.

Backup slides

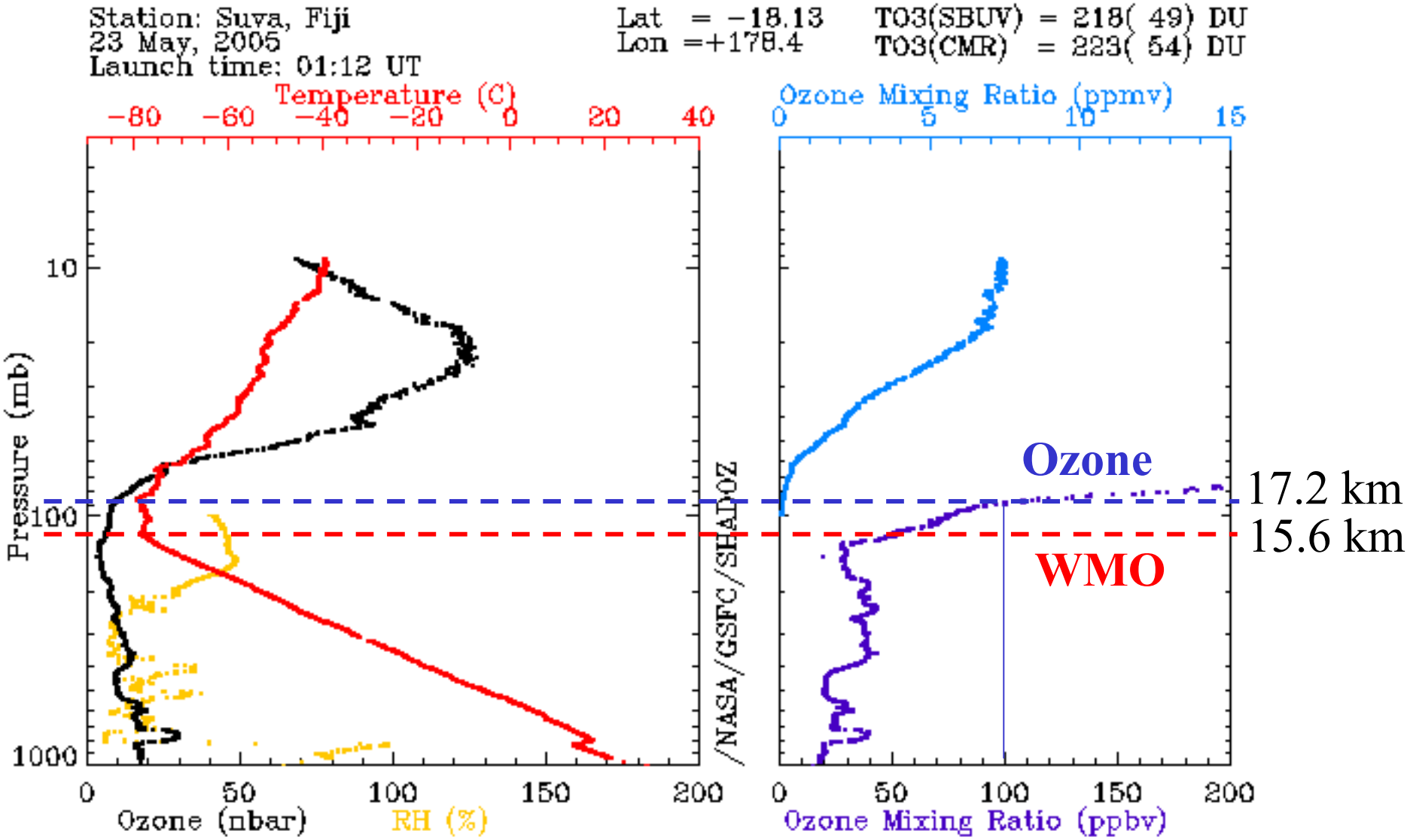

geopotential height at 200 hPa at 1:30Z15FEB2005
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120w
60w
0
11200
11400
11600
11800
12000
12200
12400
12600
GrADS: COLA/IGES
2006-09-12-18:29

Background cont.

- *Pan et al 2004*: In extratropics, a transition layer centered around WMO tropopause 2-3 km thick, and thicker near subtropical jet. Aircraft data from STRAT and POLARIS campaigns.

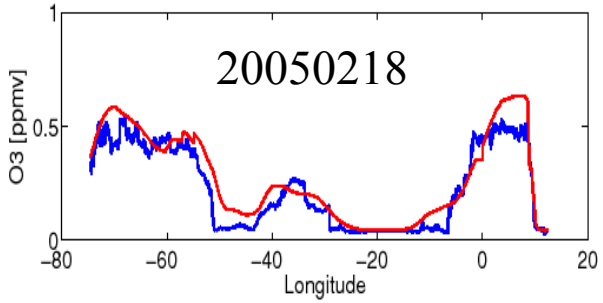


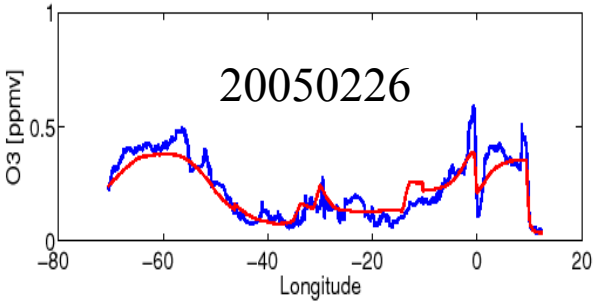
SHADOZ example 2

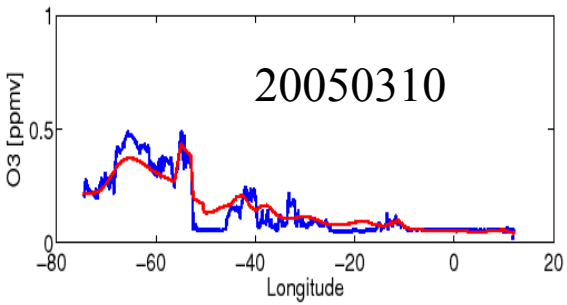


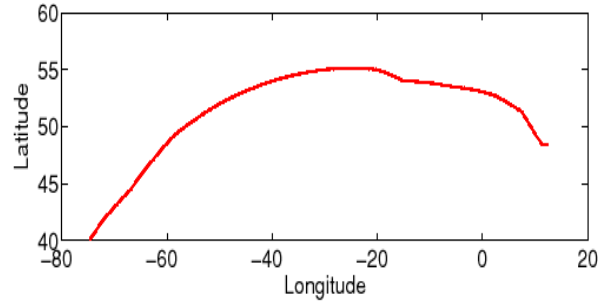
Assimilation vs MOZAIC

Charlotte-Munchen









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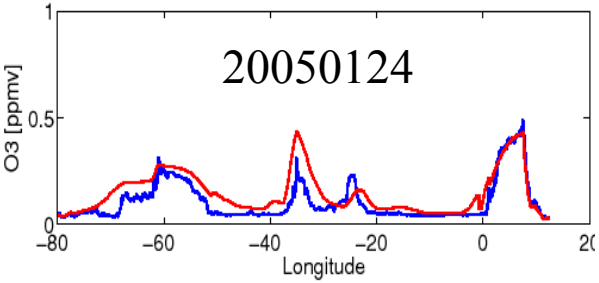
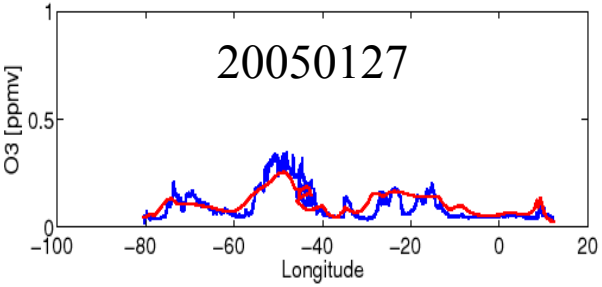
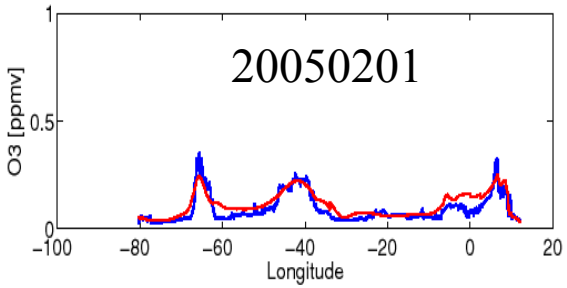
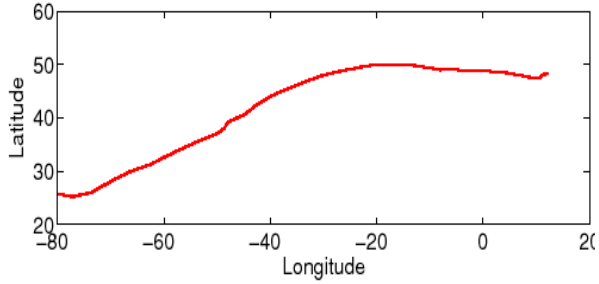
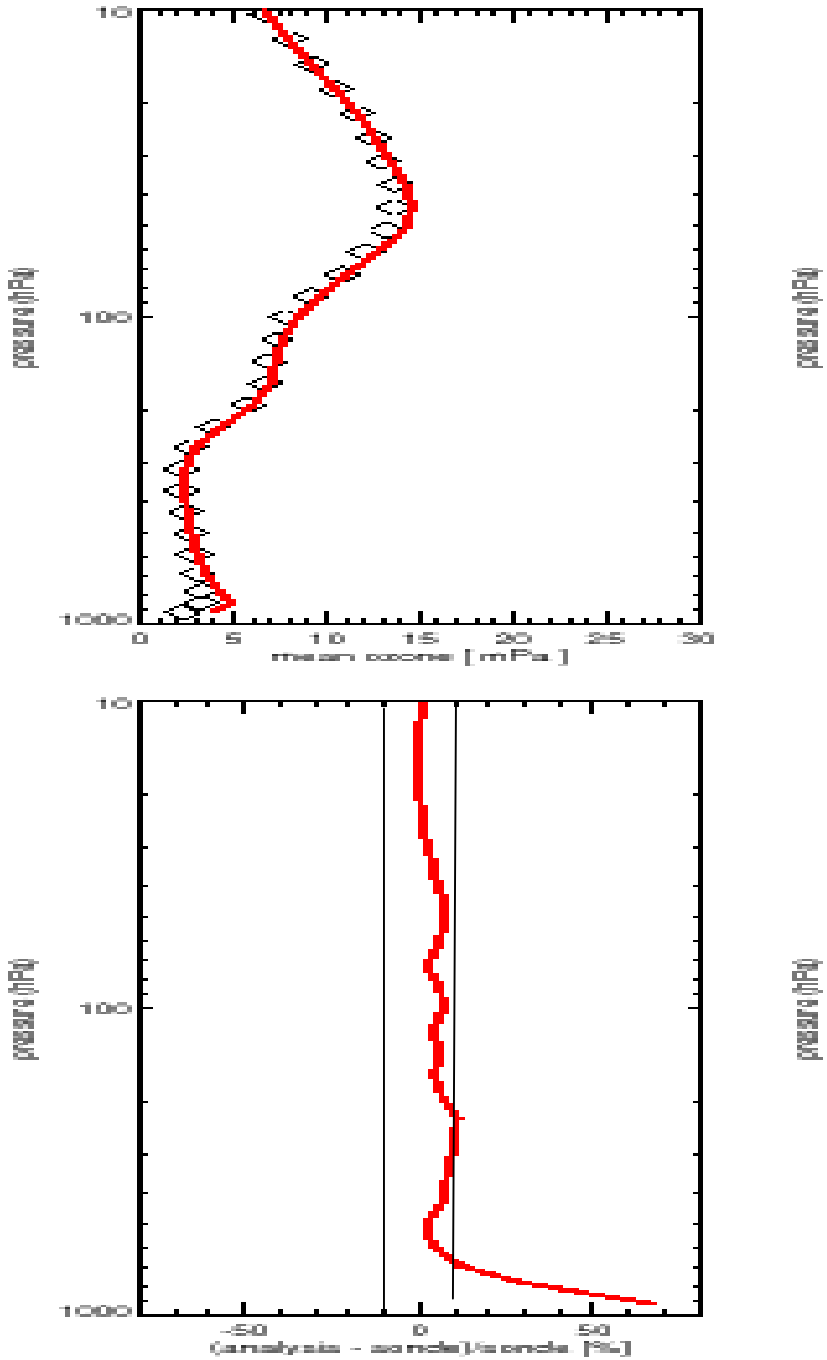
Miami-Munchen











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